CLAIMS

What is claimed is:

1. A method of providing high peak power in a pulse laser system, comprising:

providing a low-power, pulsed seed beam having a small beam diameter;

providing a pumped gain medium;

directing the seed beam through the pumped gain medium for a plurality of pre-amplification passes to produce an intermediate beam;

changing the beam diameter of the intermediate beam to produce a re-collimated intermediate beam; and

redirecting the re-collimated intermediate beam through the pumped gain medium for at least one power amplification pass to produce a high-power output beam.

2. A method according to claim 1, further comprising:

directing the re-collimated intermediate beam through the pumped gain medium for multiple power amplification passes to produce a high-power output beam.

3. A method according to claim 1, further comprising:

spatially filtering the intermediate beam while increasing its effective diameter.

4. A method according to claim 1, wherein:

the number of power amplification passes is less than or equal to the number of pre-amplification passes.

5. A method according to claim 4, wherein:

the number of pre-amplification passes is seven (7).

6. A method according to claim 1, further comprising:

controlling the re-collimated intermediate beam diameter for power amplification passes so that it is closely matched to a diameter of a pumped region of the pumped gain medium.

7. A method according to claim 1, wherein:

the pumped gain medium is a Ti:Sapphire crystal.

8. A single-stage, high peak-power femtosecond kilohertz laser system comprising:

a pumped gain medium;

means for accepting an input pulse;

means for directing the input pulse through the pumped gain medium for a plurality of pre-amplification passes to produce an intermediate beam;

means for re-collimating the intermediate beam to produce a larger effective beam diameter in the pumped gain medium to produce a re-collimated intermediate beam; and

means for redirecting the re-collimated intermediate beam through the pumped gain medium for at least one power amplification pass to produce a high-power output beam.

9. A system according to claim 8, further comprising:

means for directing the re-collimated intermediate beam through the pumped gain medium for multiple power amplification passes to produce a high-power output beam.

10. A system according to claim 8, further comprising:

a spatial filter for grooming the intermediate beam while increasing its effective diameter.

11. A system according to claim 8, wherein:

the number of power amplification passes is less than or equal to the number of power amplification passes.

12. A system according to claim 11, wherein:

the number of preamplification passes is seven (7).

13. A system according to claim 8, further comprising:

means for closely matching the diameter of the re-collimated intermediate beam during power amplification passes to a diameter of a pumped region of the pumped gain medium.

14. A system according to claim 8, wherein:
the pumped gain medium is a Ti:Sapphire crystal.

15. A single-stage, high peak-power femtosecond kilohertz laser system comprising:
a gain medium;
at least one pump laser beam creating a pumped region in the gain medium;
cavity mirrors disposed upon opposite sides of the pumped gain medium, defining a cavity within which multiple passes of a signal beam through the pumped gain medium can occur;
an input mirror for directing an input beam into the cavity for multiple pre-amplification passes to produce an intermediate beam;
a periscope for shifting an intermediate beam resulting from multiple pre-amplification passes;
a lens system for re-collimating the intermediate beam to produce a re-collimated intermediate beam with increased effective beam diameter;
one or more mirrors for directing the re-collimated intermediate beam back into the cavity for one or more power amplification passes through the gain medium; and
an output mirror for directing a high-power beam out of the system.

16. A system according to claim 15, further comprising:
retro mirrors for controlling beam path and trajectory within the cavity.

17. A system according to claim 15, further comprising:
a spatial filter associated with the lens system for grooming the intermediate beam while increasing its effective diameter.